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EXPERIMENTS INVOLVING SPECIALLY CONDITIONED EM RADIATION, GRAVITATION AND MATTER

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Abstract

Although the spacetime metric associated with gravitation can be distorted somewhat by electromagnetic influences of stupendous strength there is no strong interaction or coupling between gravitational and ordinary electromagnetic fields because they are of a different essence and form. But if ordinary em fields could be endowed with an essence and form similar to that which underlies gravitational fields, a much stronger coupling or interaction might be accomplished for propulsive use. This paper describes several ways of creating specially conditioned em radiation and how the fields associated with such radiation might interact with those associated with gravity. It also describes several experiments that have already been performed with specially conditioned em radiation, together with more comprehensive tests involving such radiation that are being studied for the future.

BACKGROUND

Millis (1) suggests that electromagnetism is a logical choice for creating an acceleration-inducing force, in that it is related in some degree to spacetime and gravity and is a technology in which we are fairly proficient. And Holt (2 has proposed the possibility of generating coherent patterns of electromagnetic (em) energy to accomplish field interactions that reduce or amplify gravitation in the vicinity of a hovering or moving ship. Unfortunately, patterns of ordinary em energy do not appear capable of such interactions. For although it is well known that the spacetime metric associated with gravitation can be distorted somewhat by em influences such as magnetic fields of stupendous strength, enormous levels of em energy are required for such distortion. And this may be because fields that underlie gravitation and ordinary electromagnetism are of different essence and form.

The behavior of all matter and radiation can be described in terms of "gauge" fields, with the sources of such fields being conserved quantities. If the essence of the generated gauge field is different from the essence of its source, the field is "abelian". If the essence of the generated field and its source are identical, the field is "nonabelian". Nonabelian fields are, therefore, sometimes viewed as being generated by themselves. Gauge fields that describe ordinary em radiation and electron/proton attraction and repulsion within atoms and molecules are abelian; while nonabelian fields are associated with processes such as weak and strong interactions within atomic nuclei. The more intricate configurations of nonabelian fields result in higher internal symmetries. Thus, abelian fields associated with ordinary em radiation are of relatively modest U(1) symmetry, while nonabelian fields associated with weak and strong interactions are SU(2) and SU(3) symmetry respectively.

Field theorists such as Yang (3) suggest that a nonabelian field underlies gravitation. If so, a significant interaction between nonabelian gravitational fields and Abelian electromagnetic fields would not be expected because of their different form. But one of us (Barrett 4, 5) has shown the possibility of transforming em fields of abelian form into specially conditioned em fields of nonabelian form and higher symmetry. And Barrett postulates the possibility of such fields coupling globally with the nonabelian gauge fields that may be associated with gravitation through a quantity that may be common to each -- the "A vector potential."

SPECIALLY CONDITIONED EM RADIATION

Although even the most complex combinations of frequency and amplitude modulation do not transform ordinary em fields into nonabelian fields of higher symmetry, Barrett (4, 5, 6) shows that such a transformation can be accomplished by modulating the polarization of em wave energy radiated from antennas or apertures or by tuning the frequency of alternating current to the toroidal geometries thru which the currents are driven. These two different methods result in em radiation whose underlying field is of SU(2) symmetry and nonabelian form. And such a field is able to couple with

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fields of similar form through the action of the A vector potential. Thus, if nonabelian gauge field configurations with SU(2) components are associated with gravitation, there should be a possibility for modifying gravity and its associated influences within beams of specially conditioned em radiation.

The propagating speed (c) of electromagnetic disturbances is determined by the electrical permittivity and magnetic permeability of the region through which they move. And since ordinary em fields do not intimately interact with gravitation and its associated spacetime metric, electrical permittivity, magnetic permeability, and the speed of light in vacuo remain unchanged. Ordinary em wave fronts therefore propagate in vacuo at constant c, as shown in Fig 1. However, if specially conditioned em beams interact with spacetime metric, permittivity and permeability and wave front speed will be changed within such beams -- and the em wave fronts would propagate, as shown in Fig 1, at variable c.

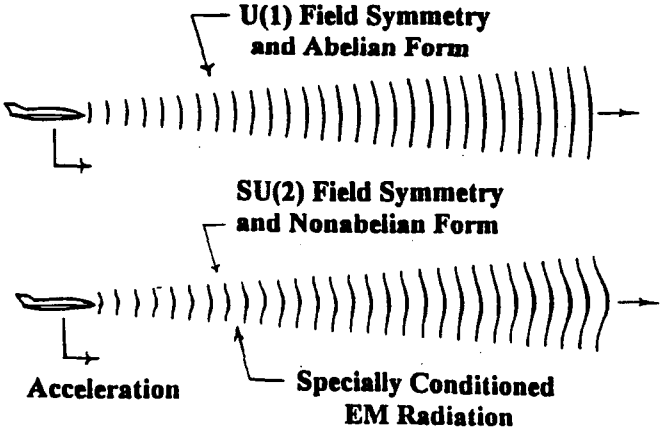

Fig 1 Electromagnetic Radiation Comparison

Higher SU(2) field symmetry requires additional terms that make Maxwell equations more symmetrical with respect to electric and magnetic phenomenon. These additional terms involve the coupling of electric and magnetic fields through the action of the A vector potential. And because the dot and cross products within the terms that include the A vector potential obey the commutation relations of nonabelian algebra and quantum mechanics, they are never equal to zero if SU(2) phenomena are present.

Ordinary em emanations are solutions to Maxwell's equations. But the U(1) symmetry of their fields is lower than the field SU(2) symmetry of specially conditioned em emanations. Electromagnetic emanations of SU(2) field symmetry must, therefore, be solutions to Maxwell equations of more expanded and symmetrical form. Barrett (4) has derived such expanded Maxwell equations, Fig 2.

SU(2)

$$\nabla \cdot E = J_0 - iq(A \cdot E - E \cdot A)$$

$$\frac{\partial E}{\partial t} - \nabla \times B + J + iq(A_0 E - E A_0) - iq(A \times B - B \times A) = 0$$

$$\nabla \cdot B + iq(A \cdot B - B \cdot A) = 0$$

$$\nabla \times E + \frac{\partial B}{\partial t} + iq(A_0 B - B A_0) + iq(A \times E - E \times A) = 0$$

A_0 = **Magnitude of Vector Potential**

Fig 2 Expanded Maxwell Equations

The additional terms associated with specially conditioned em radiation are multiplied by the mathematical quantity (i). Viewing i as an operator that rotates quantities 90 degrees with respect to two other coordinate directions (rather than as the square root of minus 1.0) enables actions involving A vector potentials to be visualized as occurring in directions orthogonal to those in which ordinary em action occurs. Thus, specially conditioned em radiation involves actions that unfold upon our familiar spacetime plane of existence and additional actions that take place in an orthogonal unobservable direction. And it is speculated that such orthogonal action (which would involve A vector potentials) is that which could conceivably warp spacetime

Creation of Specially Conditioned EM Radiation

Two identified ways of creating specially conditioned em radiation are indicated in Figure 3. One way involves the modulation of the polarization of the em radiation emitted by laser or microwave transmitters. The other way is by flow of alternating current through a toroid to generate em fields and A vector potential wave patterns. As shown in Figure 3, polarization modulation of laser or microwave transmission systems would result in elongated radiation patterns that extend over relatively long distances while patterns from toroidal transmitters would emanate over shorter distances in all directions.

If these radiation patterns would favorably warp spacetime metric such that vehicle inertia would be diminished, reduction in propulsion thrust and propellant requirement would result. In this respect, Alcubierre (7) has derived solutions to Einstein's General Relativity that involve spacetime warping as indicated in Figure 3 which results in flight impulsion - rather than flight resistance. Such extremely favorable warping - which involves compression of spacetime metric ahead of an accelerating craft, and expansion of spacetime metric behind it - would eliminate all need for propellant consuming propulsion.

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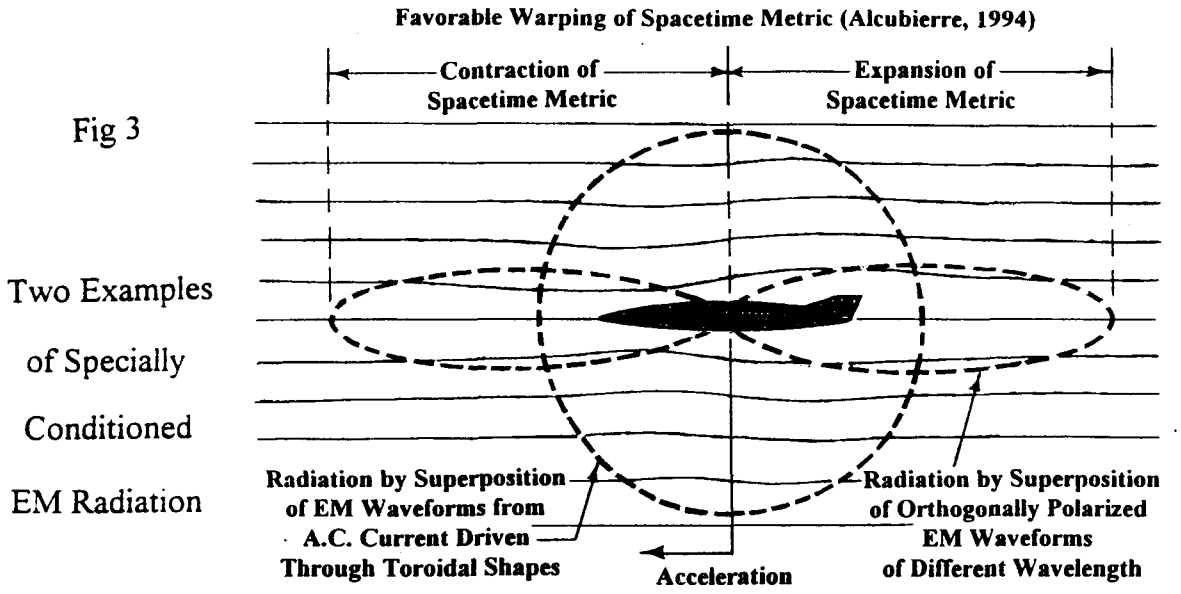
Favorable Warping of Spacetime Metric (Alcubierre, 1994)
Contraction of Spacetime Metric
Expansion of Spacetime Metric
Two Examples of Specially Conditioned EM Radiation
Radiation by Superposition of EM Waveforms from A.C. Current Driven Through Toroidal Shapes
Acceleration
Radiation by Superposition of Orthogonally Polarized EM Waveforms of Different Wavelength

Fig 3

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Electrical Power Needs

It would be desirable that specially conditioned em beams used in first-generation field propulsion systems not require significantly greater electrical power than that required by powerful radar and laser systems in use or under development for military aircraft today. But, more advanced second generation field propulsion systems that could interact more strongly with gravity could conceivably require greater electrical power than is available for air flight or spaceflight today. One example of a greater electrical power system might be the aneutronic fusion electric power system proposed by Bussard (8) which emits no neutrons and causes no radioactivity.

A more speculative possibility would be extraction of electrical energy for power from the vacuum of space itself. Here, although the vacuum seems inert and empty, quantum mechanics indicates that it is teeming with vigor and vitality - in the form of "zero-point" em pulsations throughout all space. And if favorable warping of spacetime metric could be associated with vacuum regions of negative energy density, as suggested by Alcubierre (7) and if diminished zero-point energy, (ZPE) exists within negative energy density regions - as demonstrated by the Casimir Effect (9) and as explained by Milonni (10) - such ZPE diminishment could be associated with successful ZPE extraction for shipboard power use.

Detecting Gravitational Changes Caused by Specially Conditioned Em Radiation

If gravitational changes occur within beams of specially conditioned radiation, they could conceivably be detected, as shown in Figure 4, by: changes in the masses or inertias of objects bathed by such beams; or by changes in the drag or thrust acting upon bodies that emit specially conditioned em radiation. Other detection possibilities would be to measure changes in the temporal component of spacetime (time passage) within the radiation by means of pendulums or clocks.

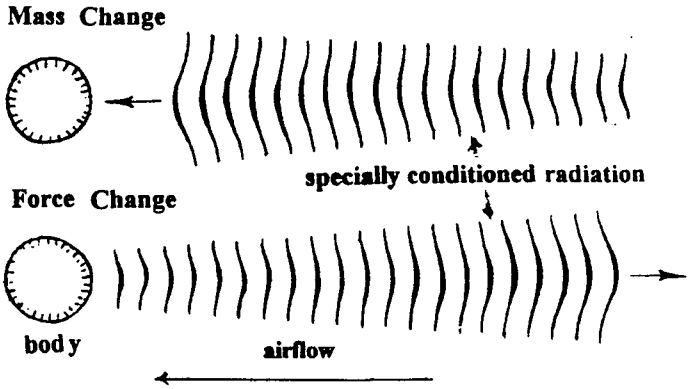


Fig 4 Electromagnetic Radiation Tests

Mass changes associated with gravitational changes can be measured by gravitometers which contain a small test mass mounted inside an enclosure. And if specially conditioned em radiation can penetrate the enclosure, changes in test mass as small as one-millionth of one percent can be detected with gravitometers that are currently available.

Another method, shown in Figure 5, would be use of a sensitive ring laser gyros (RLGs) - which are ordinarily used to detect vehicle accelerations in air or space. Barrett (5) has shown that inertial acceleration, as measured by RLGs, can be viewed as a change in the A vector potential field associated with gravitation. Thus any change in A vector potential and gravitation caused by a coupling with specially conditioned em radiation should be detectable by an RLG of sufficient sensitivity.

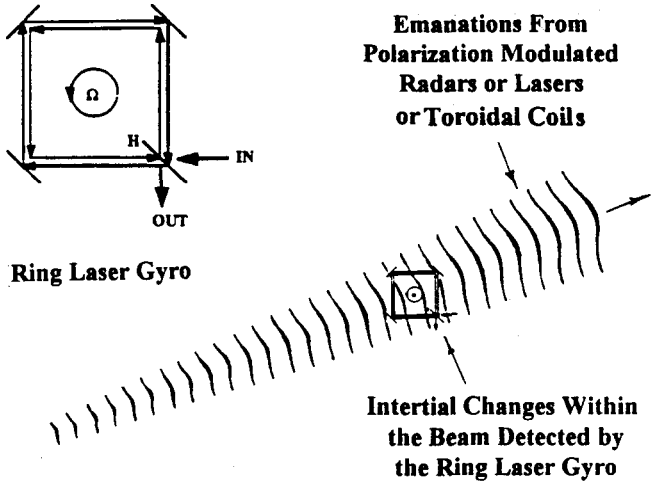


Fig 5 Probing Specially Conditioned Radiation

POLARIZATION MODULATED EM RADIATION

A means of creating specially conditioned em radiation of SU(2) symmetry and nonabelian form by means of polarization modulation is described by Barrett (4) and shown in Figure 6. Input em wave energy is seen to be divided into three fractions. One fraction has its polarity rotated 90 degrees and is then phase modulated. Another fraction is expended in accomplishing phase modulation of the polarization rotated wave energy. The remaining fraction of the input wave energy is then combined with that of the polarized and phase modulated wave energy at a "mixer", and emission of specially conditioned em radiation with continually varying polarization with respect to time results.

Upon a plane orthogonal to the axis of an em beam, only a single line or circle is traced out by the arrow of the electric field vector of linear or circularly polarized radiation, Figure 7 shows the more variegated paths traced out by the "arrow" of the electric field vector of polarization modulated radar or laser radiation after the radiation has traveled 50 and 500 wave lengths from the emitter. A phase frequency 0.1 input wave frequency is used.

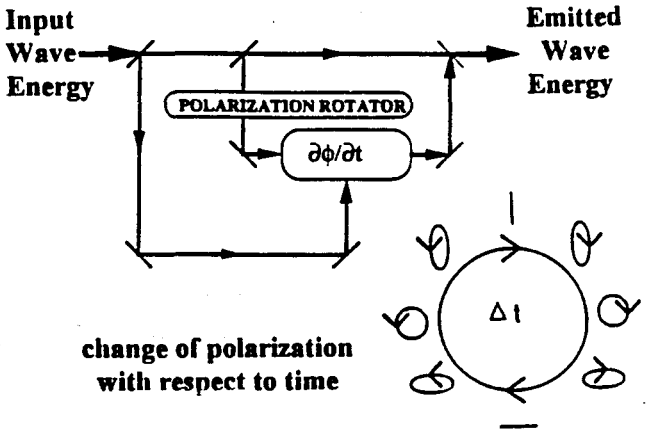
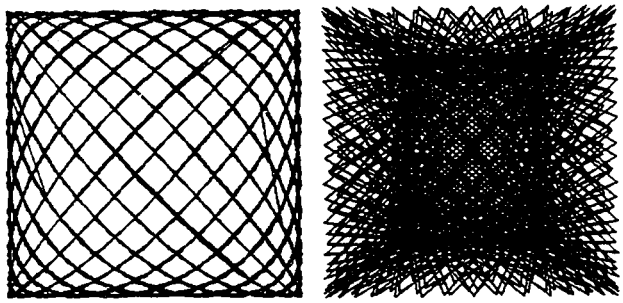


Fig 6 Polarization Modulation



After 50 Wavelengths After 500 Wavelengths

Fig 7 Electric Field Vector Histories

It is not yet obvious what portions of the em spectrum are most appropriate for interacting with spacetime metric/gravitation by means of polarization modulated radiation, or what degree of polarization modulation would maximize the interaction. For a given input power, polarization modulated radiation can be focused into beams with the narrowest width and highest intensity with laser systems, while broader beam widths of microwave systems enable a greater volume of space to be affected. Polarization modulation of both laser and microwave systems are therefore being studied and increasing amounts of modulation -- up to the highest achievable with available hardware -- investigated.

Preliminary Experiments Involving Polarization Modulated Radiation

Experimental work by Mikhailov has provided a degree of confirmation of Barrett's ideas as to the possibility of em fields with different form and higher field symmetry than that of ordinary em fields, and as to the possibility of

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coupling with such specially conditioned em fields with em fields of comparable form and symmetry. Here, experiments by Mikhailov (11), which used apparatus similar to that shown in Figure 8, has shown that ferromagnetic aerosols in solution behave as if they possess a magnetic charge, reversing their motion with reversal in magnetic field direction -- as shown in Figure 9. Barrett (12) noted that such behavior could be due to spherical boundary (cavity) conditions and global ordering of electron spins that caused the ensemble to react to magnetic influences just as many isolated magnetic monopoles would. He also determined that a nonabelian em field of SU(2) symmetry would be associated with such electromagnetics and that such an em field should therefore interact with the nonabelian field associated with polarization modulated em radiation of similar SU(2) form.

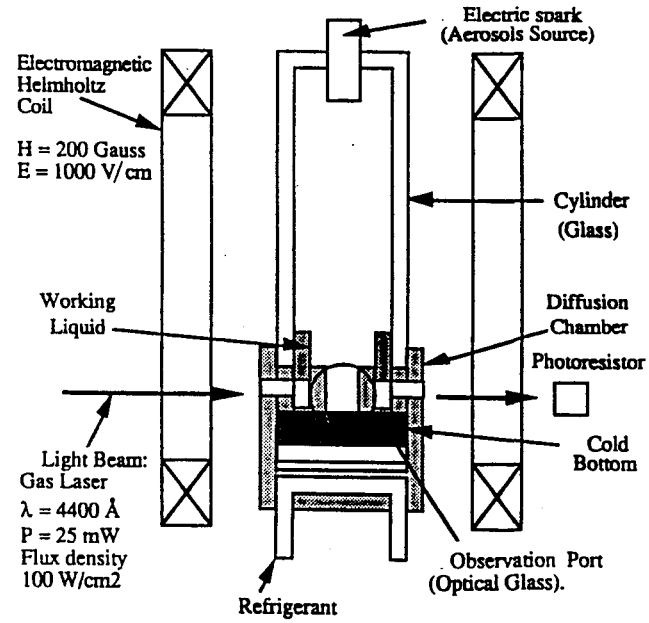

Fig 8 Ferromagnetic Aerosol Experiment

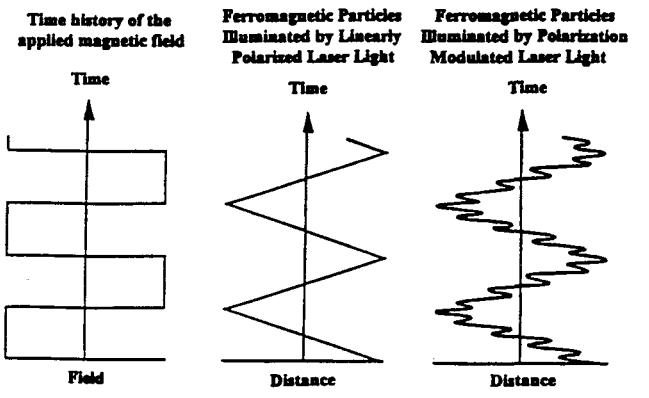

Fig 9 Ferromagnetic Aerosol Experiment

Taking this suggestion, Mikhailov (13) varied the polarization modulated laser beam used to track particle trajectories. He found that fixed polarization of the laser beam caused negligible perturbation of the straight line motion of the particles as they responded to the magnetic field. But polarization modulated light caused the particles to oscillate with respect to their motion in the magnetic field direction -- as shown in Figure 9. Unfortunately (13) contains insufficient information for ascertaining what degree of polarization modulation was actually achieved. But Mikahailov reported that oscillations maximized when a given polarization frequency was reached, and oscillations appeared to be in synchrony with the polarization modulation frequency.

Future Experiments Involving Polarization Modulated Radiation

Polarization modulation of both radar and laser transmission systems are being studied because it is not yet evident what portion (or portions) of the em frequency spectrum would provide the most favorable effect for this type of specially conditioned em radiation. Studies are being restricted to already developed systems that: (a) would require only modest modifications for polarization modulation of their emitted radiation, and (b) would use the same test facilities that the already developed systems use. Several examples of such an approach for several radar and laser test possibilities will now be described.

Polarization Modulated Microwave Radiation

One example of an experiment with polarization modulated microwave radiation would involve modification of a radar system that is currently under development for naval shipboard use. This system, shown in Figure 10, uses multiple radar frequency bands and transmit antennas - which allows relatively easy orthogonal polarization of two em wave forms, and provides the necessary phase modulation (at least a 10 percent waveform frequency difference) needed for a significant degree of polarization modulation. Testing of the modified radar system could be made in the same facilities used for its current development, and the same type of data - signal patterns and signal strengths as functions of angle and range - obtained. However, additional equipment, such as gravitometers and ring laser gyros would also be used to detect gravitational/inertial perturbations (if any) within the polarization modulated radar beam.

Another example of an experiment with polarization modulated microwave radiation would involve modification of a k-band radar transmitter that is currently being considered by NASA for supersonic wind tunnel tests.

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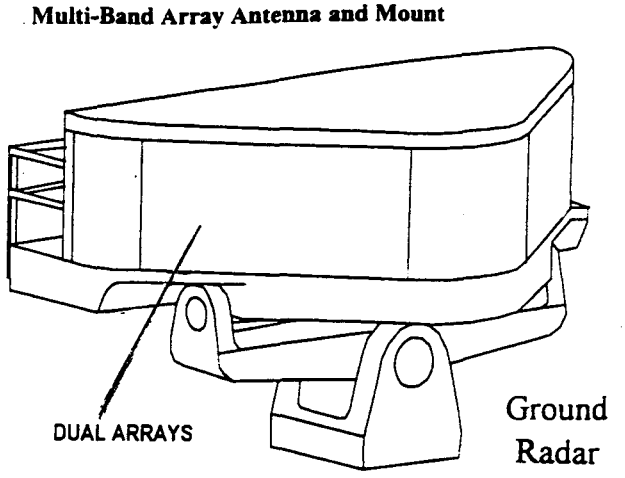

Fig 10 Microwave Test Possibility

These tests are planned to investigate vehicle drag reduction at high speeds by high power radar emissions that cause microwave breakdown and air ionization. Since currently planned wind tunnel tests involve linearly polarized radar radiation, we are studying the possibility of modifying the currently considered systems for follow-on tests that could involve other polarizations - as shown in Fig 11. Emission of polarization modulated radiation from the currently envisioned horn antenna would entail orthogonaly polarized waveforms with a frequency difference of at least 10 percent at the selected k-band frequency. Superposition of the waveforms would occur at a mixer prior to their propagation from the antenna.

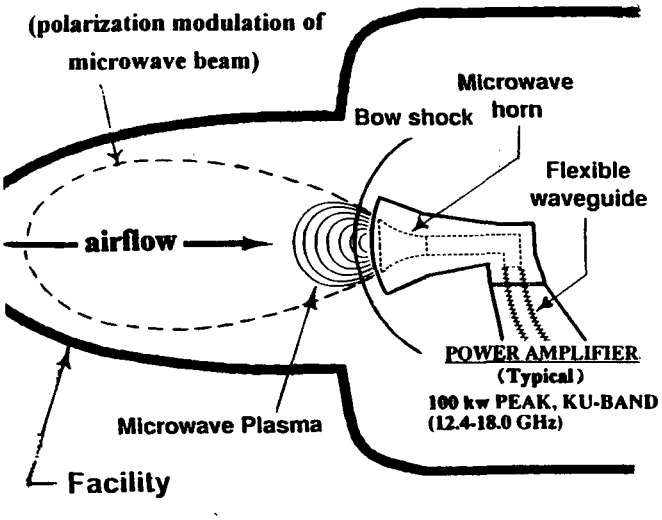

Fig 11 Wind Tunnel Test Possibility

If such polarization modulated microwave radiation couples/interacts perceptibly with gravitation to change particle mass, inertia and momentum, one would expect density and pressure perturbations within the high speed flow of air particles bathed by the radiation. And such perturbations should be detectable by planned wind tunnel test instrumentation to measure air pressure, density, velocity and flow structure in the vicinity of the emitting body, together with the pressures and drag force acting upon it.

Polarization Modulated Laser Radiation

Experiments involving polarization modulated laser radiation could involve modification of lasers currently being used for laser propulsion testing by the USAF and NASA at the White Sands Missile Range. Current tests involve vehicle propulsion by pulsed laser light that is focused into an annular region - as shown in Fig 12 - where thrust is produced from air heating and magneto gas dynamic (MGD) effects. We are studying the possibility of modifying the lasers involved in such tests for polarization modulation, and of measuring the effect (if any) of such specially conditioned laser radiation on model thrust and acceleration.

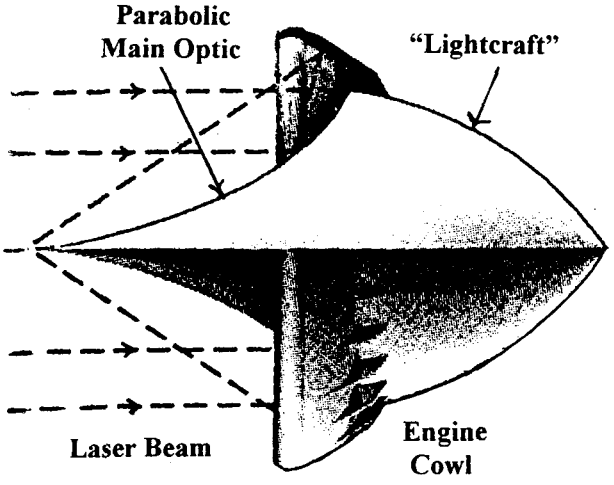

Fig 12 Lightcraft/Laser Propulsion

The laser modification would entail additional mirrors and lenses to form orthogonally polarized waveforms with a difference in wavelength of at least 10 percent. And if the polarization modulated laser radiation interacts perceptibly with gravitation, one would expect perceptible change in the mass of the model bathed by the incident radiation. One might also expect some change in thrust due to change in air density/heating or MGD effects. Thus, existing White Sands ground test instrumentation would be used to detect any changes in vehicle mass and thrust generation, while flight test instrumentation would detect trajectory changes due to changes in vehicle acceleration.

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VECTOR POTENTIAL WAVE PATTERNS

Specially conditioned em fields of SU(2) symmetry and nonabelian form can be created, as described by Barrett (16), by driving alternating current through a toroid with single windings - as shown in Figure 13. The resulting magnetic and electric fields do not extend significantly outside the toroid, but its geometry and the alternating current flow produces overlapping A vector potential patterns which extend outward from the toroid over significant distances and combine into "phase factor" waves which represent disturbances in A vector potential. The pattern of these disturbances, as shown in Figure 14, become almost spherical in shape at distances from the toroid of the order of its diameter or greater. The maximum disturbance in A vector potential occurs as phase factor wave intensity peaks at the resonant frequencies where A vector potential patterns are exactly out-of-phase.

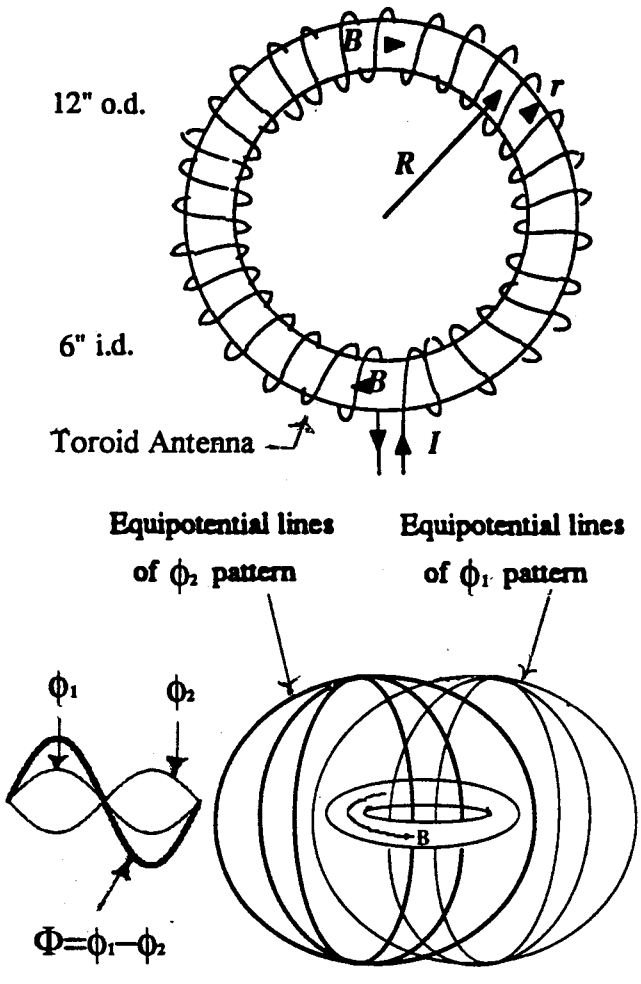
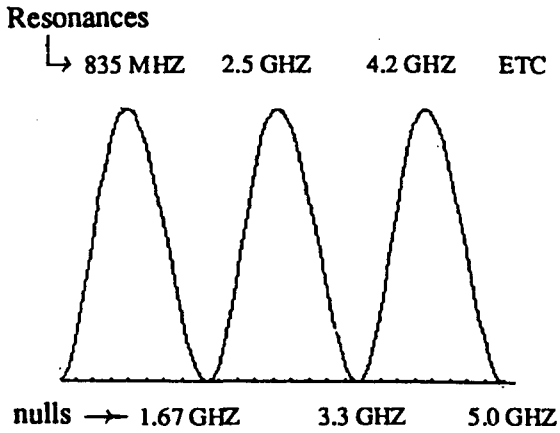


Fig 13 A Vector Potential Patterns



Resonant Frequencies

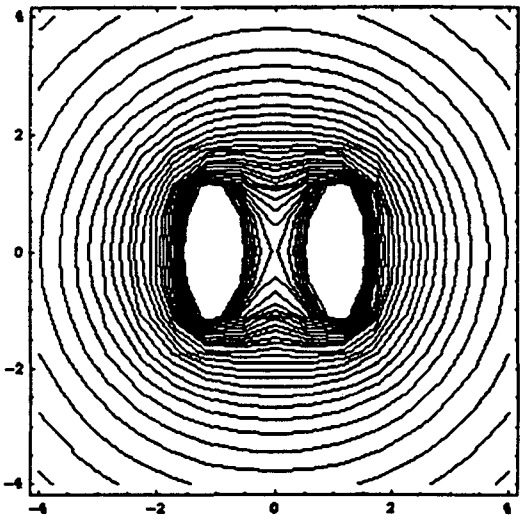


Fig 14 "Phase Factor" Wave Patterns

Resonant frequencies are determined by the dimensions of the toroid geometry and propagating speed of the alternating electric current thru it. And interactions with spacetime metric/gravitation would be expected to be the most intense at the various resonant frequencies, if an A vector potential field underlies the essence of gravitation.

Preliminary and Future Experiments Involving Vector Potential Wave Patterns

Initial work, which involved fabrication and testing of toroid antennas that emanate specially conditioned em radiation in the form of electro-magnetic and A-vector potential disturbances, has been accomplished at the laboratories of Hathaway Associates in Toronto Canada.

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The general goals of this initial work, which was performed on March 6 and 7 during 1998 were: perfection of techniques for fabricating toroidal coils; verification of ability to achieve A vector potential resonances with such coils; determination of signal strength attenuation in air and within metallic structures; and identification of problems associated with driving alternating currents through toroidal coils over wide frequency ranges and at significant power levels. The different toroid antenna configurations that were fabricated and tested are shown in Figure 15 and typical test set-ups are shown in Figures 16 and 17.

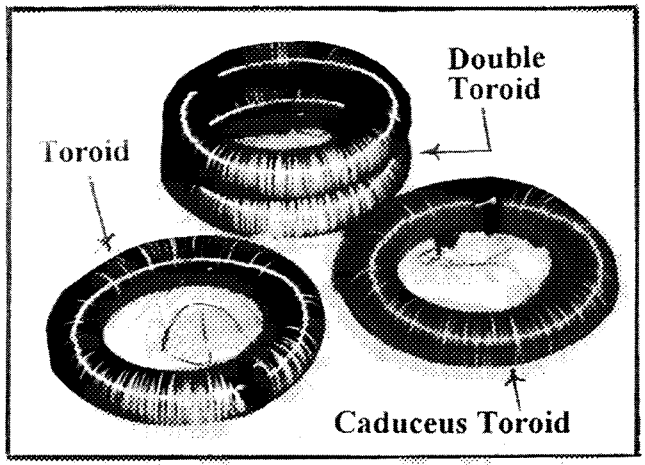
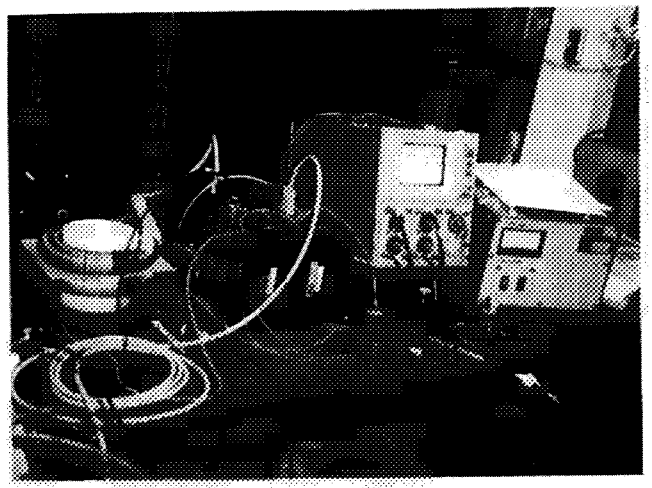


Fig 15 Toroid Configurations Tested

Fig 16 Outdoor Test Equipment

Most of the general goals were achieved. Toroid antennas with conventional and caduceus windings were successfully fabricated, and A vector potential resonances were detected at frequencies that closely corresponded to predicted values. It was also found that toroids could function as both transmitters and receivers of specially conditioned em radiation. Toroid signal strength variation with distance was as expected at small distances from the toroid center. But signal strength diminishment with distance was less than expected at longer distances. Lack of power amplification capability at very high and low alternating current frequency prevented the detection of A vector potential resonances in these regimes and lack of test time obviated tests to determine signal strength attenuation by metal structures.



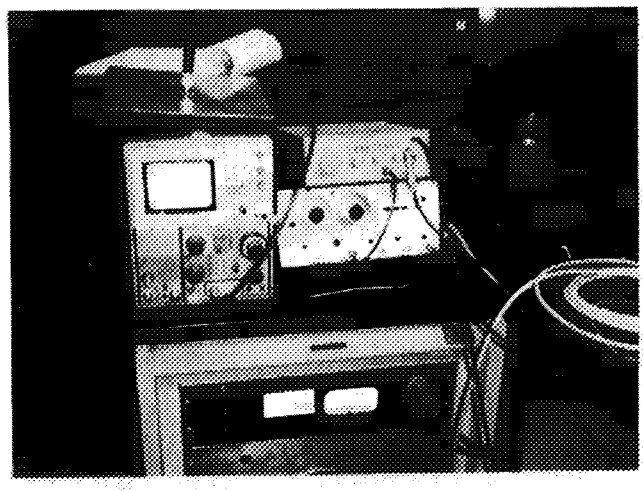


Fig 17 Indoor Test Equipment

Future Experiments Involving Vector Potential Wave Patterns

The initial experiments identified issues that must be addressed in future experiments. First, additional power amplification must be added to existing capability at Hathaway Associates in order to detect A vector potential resonances and measure signal variation with distance at very high and low a.c. frequencies - and we have determined that this can be done at a very modest cost.

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Next, the transparency of various metallic, composite and ceramic materials to specially conditioned radiation from toroid antennas must be determined to assess the feasibility of inclosing toroid antennas within aerospace vehicle structures. It must also be done to determine the possibility of toroid radiation penetrating gravitometer enclosures and changing the weight of test masses within them.

Heat generated by current flow within the toroids limited their power carrying capability to about 100 watts in the initial experiments. Since much higher levels of power will surely be required to cause any significant gravitational interaction, we are considering the possibility of: first, detecting A vector potential resonances throughout the entire available frequency spectrum with low power; then, rapidly increasing power to a much higher level and rapidly decreasing power level at each resonance, and allowing a cool-down period after each power pulsing. In this respect, toroidal coils used in operational field propulsion systems would probably use cryogenic superconducting technologies to maximize current flow and power.

If A vector potential wave patterns are found to penetrate gravitometer enclosures, we will use the precision gravitometer available at Hathaway Associates to look for gravitational perturbations caused by specially conditioned em radiation from toroid antennas. Here, a successful electrical toroid/gravitometer interface (with all test equipment interconnected and operating) was accomplished during initial work - as shown in Fig 18. A ring laser gyro will also be procured as a "back-up" means of detecting gravitational perturbations.

Fig 18 Toroid/Gravitometer Interface

SUMMARY AND CONCLUSIONS

- Ordinary em radiation does not interact intimately with gravity/spacetime metric because the fields that underlie them are of different essence and form. Thus, exorbitant expenditure of ordinary em field energy appears to be required for an interaction with gravity that causes a significant propulsive effect.

- Ordinary em radiation can be conditioned with the same field essence and form as that which may underlie gravitation. And such radiation may be able to couple propulsively with gravity through something that may be common to each -- the A vector potential.

- The efficacy of specially conditioned em radiation in accomplishing field propulsion depends upon the underlying essence of gravity — —which is not yet understood. But in the meantime, it may be possible to prove or disprove such propulsive potential by the kinds of tests described in this paper.

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